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S D. Linscombe

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**S.D. Linscombe, F. Jodari, K.S. McKenzie, P.K. Bollich,
D.E. Groth, L.M. White, R.T. Dunand, and D.E. Sanders**



Louisiana State University

Agricultural Center

Louisiana Agricultural Experiment Station

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S.D. LINScombe,¹ F. JODARI,¹ K.S. MCKENZIE,² P.K. BOLlich,¹
D.E. GROTH,¹ L.M. WHITE,¹ R.T. DUNAND,¹ AND D.E. SANDERS³

Introduction

'Bengal' is an early maturing, semidwarf, medium-grain rice variety developed at the Rice Research Station, Crowley, Louisiana. The variety was released March 1, 1992 by the Louisiana Agricultural Experiment Station in cooperation with the Arkansas Agricultural Experiment Station, the Mississippi Agricultural and Forestry Experiment Station, the Texas Agricultural Experiment Station, and the U.S. Department of Agriculture-Agricultural Research Service.

History

Bengal has the pedigree 'MARS'/'M-201'/MARS and originated from a cross made at the Rice Research Station in 1983. Mars (7) is a high yielding, early maturing, medium-grain variety released by the USDA/ARS and the Arkansas Agricultural Experiment Station. M-201 (1) is an early maturing, semidwarf, medium-grain variety released by the California Cooperative Rice Research Foundation. Bengal is an F_4 bulk of a single progeny row in the breeding nursery at the Rice Research Station in 1987, selection 8720826. It was evaluated in the preliminary yield nursery (experimental designation 8802722) in 1988 and entered into the Cooperative Uniform Regional Rice Nurseries (URRN) in 1989 with the experimental designation RU8902183.

¹Associate Professor, Assistant Professor, Associate Professor, Associate Professor, Research Associate, and Associate Professor, respectively, Rice Research Station, Louisiana Agricultural Experiment Station, LSU Agricultural Center, Box 1429, Crowley LA 70527-1429.

²Rice Breeder, Rice Experiment Station, Box 306, Biggs, CA 95917-0306.

³Specialist, Louisiana Cooperative Extension Service, LSU Agricultural Center, 252 Knapp Hall, Baton Rouge, LA 70803-1900.

The line was also entered into the statewide advanced yield (AY) testing program in 1989. In 1990, the line was entered into the statewide commercial variety (CV) test and the statewide variety by nitrogen (N) trials. In addition, cooperating pathologists began testing the line for disease reactions, and the line was entered in herbicide tolerance and gibberellic acid response screenings.

A decision was made to increase the line in the summer of 1990, and a 600-panicle row increase was planted at the winter nursery facility at Lajas, Puerto Rico in September 1990. This seed was harvested in January 1991, and an additional 500-panicle row increase was planted at the same time. The second increase was harvested in May 1991, and the seed was returned to the Rice Research Station. A 9-acre field of breeder seed was planted. A variety release meeting was held in November 1991, and a decision was made to recommend to the Louisiana Agricultural Experiment Station that the experimental line be released as a variety for commercial production. Bengal was officially released on March 1, 1992, and 160 cwt of foundation seed was made available to Louisiana producers.

Characteristics

Bengal has averaged 38 inches in plant height, compared with 47, 45, and 43 inches for Mars, 'Rico 1', and 'Orion,' respectively. The variety, because of its inherent short stature and straw strength, has displayed very good resistance to lodging. However, lodging has been observed, especially under conditions of excessive N fertilization in water-seeded systems.

The leaves of Bengal are dark green, erect, and glabrous. The blade of the flag leaf averages 13 inches in length during the booting stage. The spikelets are straw colored and awnless. Slight pubescence may be found on the lemma keel. The apiculus is straw colored. Days to 50 percent heading for Bengal, Mars, Rico 1, and Orion average 82, 81, 83, and 81, respectively.

The grains of Bengal are bolder and heavier than those of other typical southern medium grains. Grain dimensions are shown in Table 1. Bengal endosperm is non-glutinous, non-aromatic, and has a light brown bran. Bengal has displayed excellent milling characteristics. Milling yields (percent whole kernel:percent total milled) were 64-72, 63-70, 61-70, and 62-70 for Bengal, Mars, Rico 1, and Orion, respectively (URRN, 1989-91). These and other milling data are shown in Table 2.

The cooking and processing qualities of Bengal are typical of southern U.S. medium-grain cultivars. Bengal has an average apparent starch

Table 1.--Paddy, brown, and milled grain dimensions and weights of Bengal, Rico 1, Orion, and Mars rice grown at Crowley, Louisiana, in 1991

Cultivar	Length (L)	Width (W)	Thickness	L/W ratio	Weight
		-(mm)-			-(mg)-
<u>Paddy Rice</u>					
Bengal	8.27	3.15	2.14	2.63	27.4
Rico 1	7.81	3.13	2.21	2.50	27.2
Orion	8.06	3.24	2.04	2.49	23.4
Mars	8.35	3.00	2.06	2.78	23.5
<u>Brown Rice</u>					
Bengal	6.45	2.79	2.04	2.31	23.7
Rico 1	6.01	2.84	1.94	2.12	21.4
Orion	6.13	2.81	1.76	2.18	20.0
Mars	6.26	2.53	2.06	2.47	21.2
<u>Milled Rice</u>					
Bengal	6.04	2.64	1.92	2.29	21.8
Rico 1	5.66	2.66	1.81	2.13	19.9
Orion	5.72	2.65	1.72	2.16	18.9
Mars	6.07	2.46	1.81	2.47	18.7

amylose content of 13.7% and a low gelatinization temperature (65 to 68°C), as indicated by an average alkali spreading reaction of 5.6.

Variants observed and removed from increase fields of Bengal were taller and included any combination of the following: pubescent, earlier, later, and intermediate grain type. The total number of variants numbered less than 1 per 5,000 plants.

Classes of seed will be breeder, foundation, registered, and certified. Breeder and foundation will be maintained by the Rice Research Station, P.O. Box 1429, Crowley, Louisiana 70527-1429.

Yield

Bengal has excellent grain yield potential. Average yields (lb/A) were 7355, 6115, 7002, and 6538 for Bengal, Mars, Rico 1, and Orion, respectively (URRN, 1989-91). These and other yield data are shown in Table 2. In limited testing, Bengal has displayed good to excellent ratoon crop potential.

Table 2.--Comparative yield and milling tests of Bengal, Mars, Rico 1, and Orion by researchers from the Rice Research Station and cooperators from adjacent states, 1989-91

Year	Test-Location	Bengal		Mars		Rico 1		Orion	
		Yield (lb/A)	Milling % Head-Total	Yield (lb/A)	Milling % Head-Total	Yield (lb/A)	Milling % Head-Total	Yield (lb/A)	Milling % Head-Total
1989	URRN1-Crowley, LA	7209	64-69	5320	60-66	5954	61-68	6378	63-69
	URRN-Stuttgart, AR	8939	70-76	5958	66-71	8732	61-72	5710	66-72
	URRN-Stoneville, MS	8122	50-70	6970	68-69	7771	70-73	7414	64-71
	URRN-Beaumont, TX	6092	62-71	5141	65-71	5749	53-69	5700	65-71
	AY2-Crowley, LA	6555	63-70	-----	-----	7959	62-70	-----	-----
	AY-Lake Arthur, LA	5851	55-64	-----	-----	6158	55-64	-----	-----
	AY-Cheneyville, LA	7176	66-70	-----	-----	7196	64-70	-----	-----
	AY-Epps, LA	7680	60-74	-----	-----	8701	63-74	-----	-----
	AY-Jones, LA	8338	66-71	-----	-----	8695	65-71	-----	-----
1990	URRN-Crowley, LA	8491	69-75	7089	63-74	7073	62-70	7635	56-74
	URRN-Stuttgart, AR	7961	65-72	7689	65-71	9311	62-73	7214	64-70
	URRN-Stoneville, MS	8520	67-70	6994	63-68	8877	63-70	8442	61-68
	URRN-Beaumont, TX	4917	60-70	5133	56-69	4342	51-67	5064	57-69
	AY-Crowley, LA	7357	64-71	-----	-----	8845	62-68	-----	-----
	AY-Lake Arthur, LA	6348	63-69	-----	-----	6597	62-69	-----	-----
	AY-Cheneyville, LA	8511	64-69	-----	-----	8442	64-70	-----	-----
	AY-Epps, LA	9870	69-73	-----	-----	10245	64-72	-----	-----
	AY-Jones, LA	8635	64-70	-----	-----	7662	61-69	-----	-----
	CV3-Crowley, LA	8080	66-72	8286	65-70	8066	65-71	7019	63-71
	CV-Epps, LA	9835	69-73	7039	65-69	10208	64-72	8023	65-70
	CV-Pine Island, LA	5577	-----	5029	-----	5105	-----	5382	-----
	CV-St. Joseph, LA	8145	-----	6386	-----	8463	-----	6975	-----
1991	URRN-Crowley, LA	5836	60-69	3671	61-68	4992	59-68	4834	58-69
	URRN-Stuttgart, AR	7567	70-72	7363	68-71	8465	68-73	7324	65-70
	URRN-Stoneville, MS	9122	65-72	6862	67-70	7877	60-69	7571	67-70
	URRN-Beaumont, TX	5479	61-72	5199	59-70	4882	59-69	5172	58-71
	AY-Crowley, LA	6429	64-72	-----	-----	7584	63-71	-----	-----
	AY-Lake Arthur, LA	6413	61-69	-----	-----	5310	59-69	-----	-----
	AY-Cheneyville, LA	6695	64-73	-----	-----	7022	64-72	-----	-----
	AY-Epps, LA	9315	67-71	-----	-----	9851	65-70	-----	-----
	AY-Jones, LA	9022	64-72	-----	-----	10105	65-71	-----	-----
	CV-Crowley, LA	6381	63-69	6453	63-69	7390	63-69	6355	65-70
	CV-St. Joseph, LA	7227	-----	7492	-----	8730	-----	7068	-----

1 URRN = Cooperative Uniform Regional Rice Nursery (Data provided through the courtesy of Kenneth Gravois and Karen Moldenhauer, Rice Research & Extension Center, Stuttgart, AR; Dwight Kanter, Delta Research and Extension Center, Stoneville, MS; C.N. Bollich and Anna McClung, Texas A&M Research and Extension Center, Beaumont, TX.).

2 AY = Advanced Yield Test (Rice Research Station, Crowley, LA; Lounsberry Farm, Lake Arthur, LA; Bollich Farm, Cheneyville, LA; Perry Farm, Epps, LA; Zaunbrecher Farm, Jones, LA).

3 CV = Commercial Variety Test (Rice Research Station, Crowley, LA; Perry Farm, Epps, LA; Trahan Farm, Pine Island, LA; Northeast Research Station, St. Joseph, LA).

Cultural Management

Agronomic performance of Bengal, as with most semidwarf varieties, will be highly dependent on cultural management. Grain yields of Bengal are moderately high without intensive water management or high rates of

fertilizer N. Maximum yield potential will, however, occur with ideal growing conditions and optimum cultural management, especially with respect to fertilizer N and water management.

Seedling vigor of Bengal is good in a drill-seeded system when compared with other medium grains. Careful attention during stand establishment is still necessary for best performance. Bengal should be planted into weed-free, uniform, and level seedbeds and should be seeded less than 1 inch deep for best results.

Bengal has displayed very good seedling vigor when water seeded. The seedbed should be prepared in a roughened, cloddy, or grooved condition to minimize seed drift and to promote rapid seedling anchorage and stand establishment. In either cultural system, water management will have a significant influence on stand establishment, early season plant growth, and grain yield. Fields should be levelled with no more than a 0.2 foot fall between levees. Less fall is desirable as long as drainage is not impaired.

In drill-seeded or dry-broadcast plantings, approximately 15 to 30 units of N per acre should be incorporated prior to planting. This preplant N encourages early growth and more rapid stand establishment and will often allow for earlier permanent flood establishment. On soils requiring phosphorus, potassium, sulfur, or zinc, these applications should also be made preplant. A soil test is an excellent diagnostic tool for determining the requirements of rice for most nutrients, with the exception of N.

Flushing may be necessary for stand establishment if seedbed moisture is inadequate. Flushing will promote uniform emergence and more rapid stand establishment. By the fourth or fifth leaf stage, or about 30 to 35 days after seeding, all or most of the required N should be applied to a preferably dry seedbed just prior to establishing a shallow, permanent flood. Applying fertilizer N into the flood on young seedling rice should be avoided since this is the most inefficient method of N management. Delaying N application and permanent flood establishment should also be avoided since reduced tillering, increased weed problems, lower fertilizer efficiency, and decreased grain yields may occur.

In the water-seeded, pinpoint flood system, all or most of the required N and any other fertilizer nutrient should be preplant incorporated into a dry seedbed. If the field is drained for an extended period of time after water-seeding, and establishment of permanent flood is delayed, N should be applied and managed as in the dry-seeded system.

Regardless of planting method, it is often necessary to apply N at midseason, especially if only a portion of the total N requirement was applied at planting. Generally, 30 to 50 units per acre are adequate, provided

that sufficient basal N was properly applied. The rice crop should be monitored on a regular basis for N deficiency symptoms, and topdress applications should be made during early reproductive growth or when deficiency becomes apparent. Corrective applications of N should be applied by the panicle differentiation (PD) stage. It is questionable whether yield responses occur when N is applied after PD.

Bengal has displayed susceptibility to the physiological disorder straighthead. On soils where straighthead is known to occur, water and N management should be modified. Only 50 to 60 percent of the required N should be applied either preplant or preflood, depending on the cultural system. The field should be drained during mid-tillering and allowed to dry. Complete aeration of the soil is necessary to alleviate potential damage due to straighthead. The remaining N should then be applied, and the field reflooded by the panicle initiation (PI) or green ring growth stage. The DD-50 Rice Management Program can be used to predict the dates to drain for straighthead and to reflood at PI (8).

The potential for optimum second crop yields will be greater when Bengal is planted early, when main crop stubble has not been damaged by field rutting at harvest or by disease in the main crop, and when additional N is applied to the second crop. Up to 75 units of N should be applied immediately after main crop harvest, followed by a shallow, permanent flood.

Emergence and seedling growth of Bengal, like other semidwarf varieties, are increased by gibberellic acid. Evaluations in 1991 and 1992 showed Bengal planted 3 inches deep at 100 lb/A, under different environmental conditions, had an average stand of 7 plants/ft² (2,4). Stand was increased to a more desirable density of 11 plants/ft² by seed treatment with gibberellic acid. Stands between 10 and 20 plants/ft² are considered adequate for maximum grain yield. Mars, the tall parent of Bengal, produced an adequate stand of 11 plants/ft² without gibberellic acid seed treatment. With gibberellic acid seed treatment, the stand of Mars improved to 17 plants/ft². Following stand establishment, applying gibberellic acid to seedlings (3- to 4-leaf stage) of Bengal increased plant height nearly 2 inches above normal in 7 days after treatment (3,5). Comparable responses in Mars averaged less than 1 inch.

The use of gibberellic acid seed treatment on Bengal is prudent when dry planting deep to reach available moisture. Planting to moisture takes advantage of available soil moisture for germination and reduces flushing. Following emergence, application of gibberellic acid to Bengal timed with postemergence herbicides can provide the extra seedling height needed to

establish an early, uniform flood. Flooding quickly behind a postemergence herbicide application enhances weed control and reduces multiple postemergence herbicide applications prior to flood.

Bengal has been screened for injury from registered rice herbicides and has not displayed unusual susceptibility from labeled application rates. It should be noted that there is always potential for rice injury from some herbicides due to specific environmental conditions.

For a more detailed discussion of all aspects of rice fertilization and cultural management, refer to the *Rice Production Handbook* (Louisiana Cooperative Extension publication 2321) (8).

Pest Reaction

Bengal is susceptible to rice blast (*Pyricularia grisea* Sacc.) races IB-1 and IB-49, and moderately resistant to resistant to the other blast races. Under field conditions, Bengal, like Mars, developed rotten neck blast under epidemic conditions, and fields should be scouted for disease development. To reduce damage from blast, avoid late planting (after May 1) and do not allow the field to dry after the permanent flood is established (except if draining for straighthead). Increasing flood depth (up to 6 inches deep) after the PI stage and avoiding excessive N may also reduce the potential for blast.

Bengal, like Mars, was rated moderately susceptible to sheath blight (*Rhizoctonia solani* Kuhn) in inoculated disease nurseries in Crowley, Louisiana. Growers are encouraged to avoid dense stands and excessive N fertilizer.

Bengal was rated moderately resistant to leaf smut (*Entyloma oryzae* H. & D. Snyder) and resistant to narrow brown leaf spot (*Cercospora janseana* (Racib) O. Const.), and it appears resistant to brown leaf spot (*Cochiobolus miyabeanus* (Ito & Kur) Drech) in limited testing under natural inoculum pressures in Louisiana disease nurseries. These diseases rarely occur with enough severity to warrant disease control measures, but scouting is recommended to monitor disease development. Bengal is very susceptible to straighthead and moderately susceptible to panicle blight.

Fields should be scouted weekly for disease development beginning when the first tillers begin to develop and continuing through heading. Rice should be sampled at several (20 or more) locations throughout the field. The size of the field and the disease distribution will determine the extent of sampling. At each sampling location, 25 to 50 tillers should be examined for disease symptoms. Refer to Louisiana Agricultural Experiment Station Bulletin No. 828, *Rice Diseases and Disorders in Louisiana*, for more

information on scouting for these diseases (6). Other diseases that require fungicides for control, especially the rice blast disease, must be noted between scouting stops as damaging levels can develop from light infestations that are not detected at the scouting stops. For sheath blight, the percentage of tillers infected at the sampling locations should be averaged to determine the disease incidence for the field. A fungicide application for sheath blight may be necessary on Bengal to maximize yields if infestation exceeds 20% of the tillers infected during the jointing stages of growth. Unfortunately, there is not a good scouting/ prediction system for blast at this time, and when leaf blast is found, preventative sprays at boot and heading are indicated. Consult your Cooperative Extension Service agent for the latest information on fungicide usage.

DD-50 Rice Management Program

DD-50 growth stage information has been developed for Bengal, and growers are encouraged to participate in this program for assistance in making management decisions (8). This program is available through the county agent's office in each rice-growing parish.

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